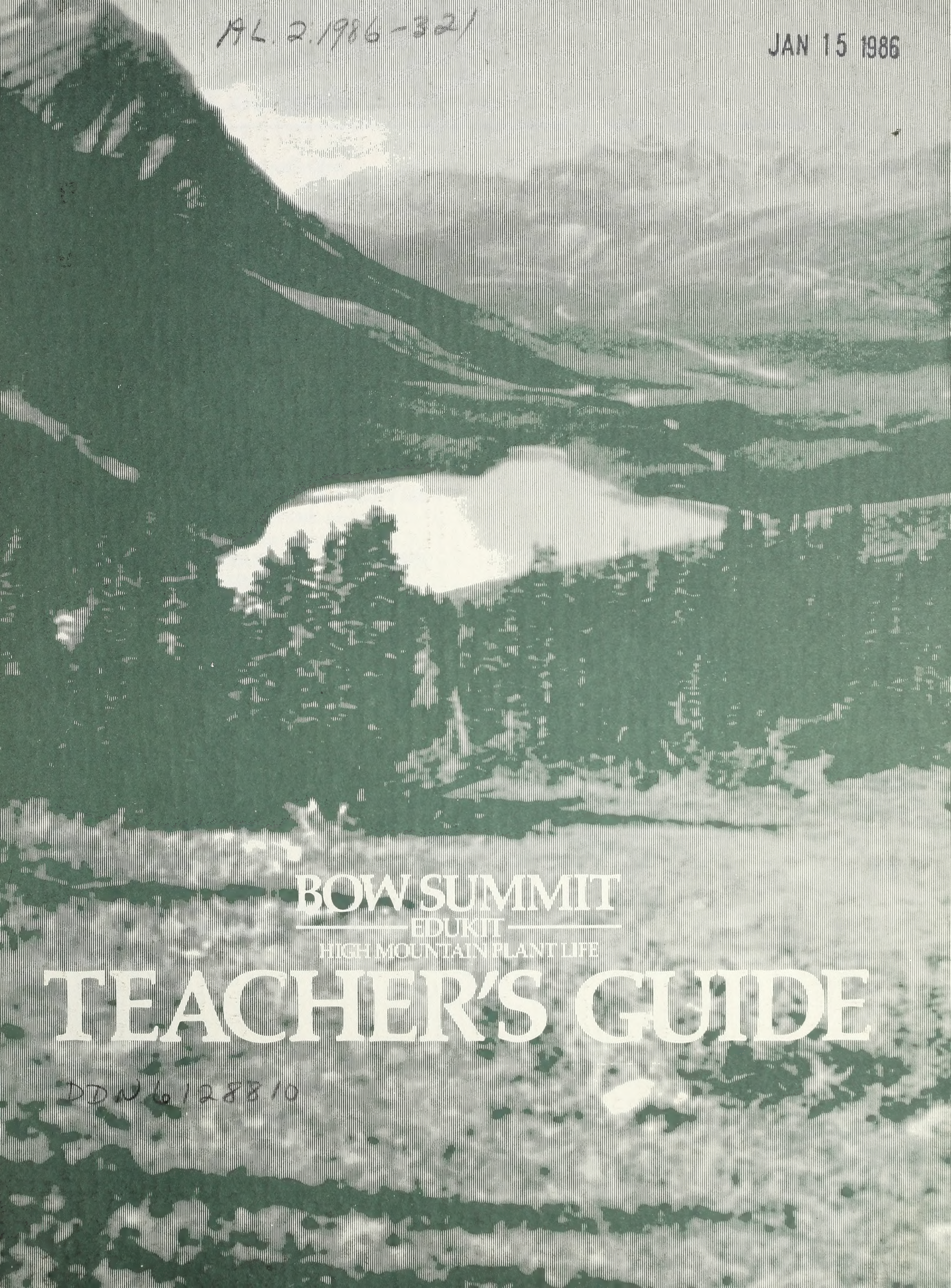
AL.2.1986-321

JAN 15 1986



BOW SUMMIT
EDUKIT
HIGH MOUNTAIN PLANT LIFE
TEACHER'S GUIDE

DDN6128810

NATIONAL LIBRARY OF CANADA
BIBLIOTHÈQUE NATIONALE DU CANADA

Digitized by the Internet Archive
in 2017 with funding from
University of Alberta Libraries

https://archive.org/details/bowsummitedukith00albe

Table Of Contents

1 What It's All About: Introduction 2

2 Theme, Goals, and Objectives 3

3 Here's What You Get:
Print and Audiovisual Components 3

4 How To Use It: suggestions for lesson formats, including questions and answers for each program 4

Program 1 – SETTING THE STAGE
The processes that created the Bow Summit landscape: mountain building, erosion, and glaciation 6

Program 2 – A CLIMATE FOR GROWTH
Climate and soils and their relevance to plant life 12

Program 3 – PATTERNS – A MOUNTAIN PATCHWORK
A description of vegetation zones: subalpine, tree line, and alpine 17

Program 4 – ADAPTATIONS – A STRUGGLE FOR SURVIVAL
Plant adaptations to a harsh environment 22

Program 5 – AND THEN CAME PEOPLE
Series overview and the impact of people on the fragile landscape 29

5 And at the back:
series test,
the science-process approach,
and suggested readings. 32

WHAT IT'S ALL ABOUT . . .

The Bow Summit Edukit tells the story of the colonization of flora through the interaction of landscape and climate. Its setting is the subalpine/alpine region of the Rocky Mountains at Bow Summit in Banff National Park.

The Bow Summit Edukit is a co-production of Parks Canada and ACCESS Alberta. It is compatible with both the objectives of Parks Canada and the school curricula in the province of Alberta. Parks Canada's objective for national parks is:

> **to protect for all time representative natural areas of Canadian significance in a system of national parks, and to encourage public understanding, appreciation, and enjoyment of this natural heritage for future generations.**

The Edukit was produced to tell the story of Bow Summit to Alberta students. The kit uses a multi-disciplinary approach to the topics of plant adaptation, succession, and colonization. Students should have previous knowledge of basic abiotic factors such as climate, erosion, and glaciation as well as plant ecology to utilize the kit and field trip to maximum advantage. The kit is readily usable as part of the curriculum for a Biology Ten unit on plant ecology. The kit may have limited use for the Grade Seven biology course but **only** after the primary ecological concepts of plant ecology have been thoroughly taught. The kit's questions for grade seven students should be looked at carefully and some modified or deleted for use at this level. To discover the interests and needs of Alberta teachers, a questionnaire was distributed to schools in the province. The questionnaire and its responses are included in the kit for your reference. Many of the teacher suggestions were incorporated into the design of the Edukit. The responses indicated an interest in both on-site and in-classroom components. Study aids have been prepared for classroom instruction and a field guide for on-site use. The Edukit has been designed with flexibility so that it may be adapted to the particular needs of each teacher.

The Natural and Human History of Banff National Park is included in the Edukit in response to the diverse interest expressed in this area.

THEME, GOALS AND OBJECTIVES

THE PRIMARY THEME of the Bow Summit Edukit is the colonization of flora through the interaction of landscape and climate. The Edukit describes and illustrates the following with reference to the Bow Summit area:

(a) the processes of mountain building
(b) the climate and soils, and their importance in determining the plant life there
(c) the vegetation pattern
(d) the specific plant adaptations in each of the vegetation zones.

The Bow Summit Edukit helps to achieve the following:

1 LEARNER GOALS

As a result of using the Edukit, learners will become aware of:

(a) the significance of the colonization of flora as represented at Bow Summit.
(b) Bow Summit as but one focal point in the Rocky Mountains which illustrates these processes.
(c) the fragility of the Bow Summit area.
(d) the significance and importance of the heritage values protected in national parks.

2 LEARNER OBJECTIVES

As a result of using the Edukit, learners will be able to:

(a) understand how different environmental conditions in the subalpine, alpine, and timberline result in differences in the vegetation patterns.
(b) comprehend the relationship of climate to topography and how this affects the vegetation.
(c) understand the sensitivity of high-altitude vegetation communities.
(d) develop an interest in the alpine/subalpine environments.

HERE'S WHAT YOU GET...

PRINT COMPONENT:

- BOW SUMMIT: HIGH MOUNTAIN PLANT LIFE: TEACHER'S GUIDE
- BOW SUMMIT: WHAT TO DO WHEN YOU GET THERE: A TEACHER'S GUIDE FOR A FIELD TRIP
- PROGRAM TRANSCRIPTS
- THE NATURAL AND HUMAN HISTORY OF BANFF NATIONAL PARK
- BOW SUMMIT (brochure)
- POSTERS
- RESULTS FROM "NEEDS AND INTERESTS" QUESTIONNAIRE DISTRIBUTED TO ALBERTA TEACHERS
- OPERATING INSTRUCTIONS FOR VIDEO CASSETTE AND SLIDE/TAPE PROGRAMS

AUDIOVISUAL COMPONENT:

Slide/tape programs: the kit includes five carousels of slides with five audio cassettes.

Program 1 – SETTING THE STAGE
Program 2 – A CLIMATE FOR GROWTH
Program 3 – PATTERNS – A MOUNTAIN PATCHWORK
Program 4 – ADAPTATIONS – A STRUGGLE FOR SURVIVAL
Program 5 – AND THEN CAME PEOPLE

Video cassette: the five slide/tape programs transferred to one, sixty-minute cassette.

HOW TO USE IT:

suggestions for lesson formats, including questions and answers for each program

Your Edukit contains both slide/tape programs and a video cassette. The video cassette contains all five slide/tape programs and is approximately sixty minutes in length. It is easy to use, but can only be viewed on a standard television screen. It is recommended that the video cassette be utilized as a condensed information package to motivate students prior to a field trip.

The major instructional medium for classroom use is the slide/tape program. Each program is designed as a separate lesson and is about ten minutes in length. A format for each lesson utilizing the slide/tape program could include:

1 . . . **a sneak preview**
A transcript of each program is included in the Edukit to enable you to review program content before presentation. Key words identifying major program concepts are indicated by boldface type in the transcripts.

2 . . . **lights, camera, action**
You can now present the slide/tape program to your class. Instructions for operating the slide projector and cassette recorder are included in the Edukit.

3 . . . **questions, anyone?**
In order to review the slide/tape programs with your class, three types of questions have been prepared for each program:

Subject questions, focussing on content recall
questions incorporating science-process skills
activity-oriented questions, offering a lighter, interactive approach.

Each type of question covers all major concepts in that program. Select whatever types of question you prefer and xerox them, if you wish. Answers to the questions are included at the back.

4 . . . **and now for a short quiz.**
A xeroxable review of all five programs is included at the back, with answers. The review could also be xeroxed and distributed to your students.

QUESTIONS INCORPORATING SCIENCE-PROCESS SKILLS - APPROACH

Following are questions incorporating science-process skills. After answering a question, list the science-process skill(s) inherent in that question. The skills given are suggestions only. Different individuals may utilize different skills, but they should be able to explain which skills were used and why.

SUMMARY OF PROCESSES IN SCIENTIFIC INQUIRY

INITIATION

1 Problem identification and definition

2 Seeking background information

3 Predicting

4 Hypothesizing

5 Designing collection of data through field work and/or experimentation.

COLLECTION OF DATA

6 Procedure

7 Observing and observations.

PROCESSING DATA

8 Organizing the data

9 Representing the data graphically

10 Treating the data mathematically.

CONCEPTUALIZATION OF DATA

11 Interpreting the data

12 Formulating operational definitions

13 Expressing data in the form of a mathematical relationship

14 Incorporation of the new discovery into the existing theory (developing a "mental model").

OPENENDEDNESS

15 Seeking further evidence

16 Identifying new problems for investigation

17 Applying the discovered knowledge.

Nay, M.A. "A Process Approach to Teaching Science", *Science Education*, 55:pp. 197 - 207, 1971.

BOW SUMMIT PROGRAM 1

Subject questions

1 What is the major story portrayed by the Bow Summit Edukit?

2 Is the use of the phrase "pioneer plant" dramatic or technical?

3 In what way are the plants of Bow Summit like pioneers?

4 Where is Bow Summit located?

5 How high is Bow Summit in comparison to the city of Calgary?

6 What is Bow Summit?

7 Most of the bedrock in the Rocky Mountains is sedimentary rock. How was this rock formed?

8 What are the two main types of rock found at Bow Summit?

9 What is a fossil?

10 What do marine fossils at Bow Summit suggest about the formation of the bedrock?

11 What caused the bedrock to rise out of the shallow sea and create the Rocky Mountains? Describe the effects of this development.

12 As the Rocky Mountains were formed, erosion slowly began to change their shape. Name two agents of erosion.

13 How does water freezing in cracks in rock create smaller rock particles?

14 How does water cut "V"-shaped channels in rock?

15 If the Mistaya Valley was once a complete arch of rock, what first carved a valley with steep, "V"-shaped sides?

16 What icefield and glacier can be seen from Bow Summit?

17 How are icefields formed?

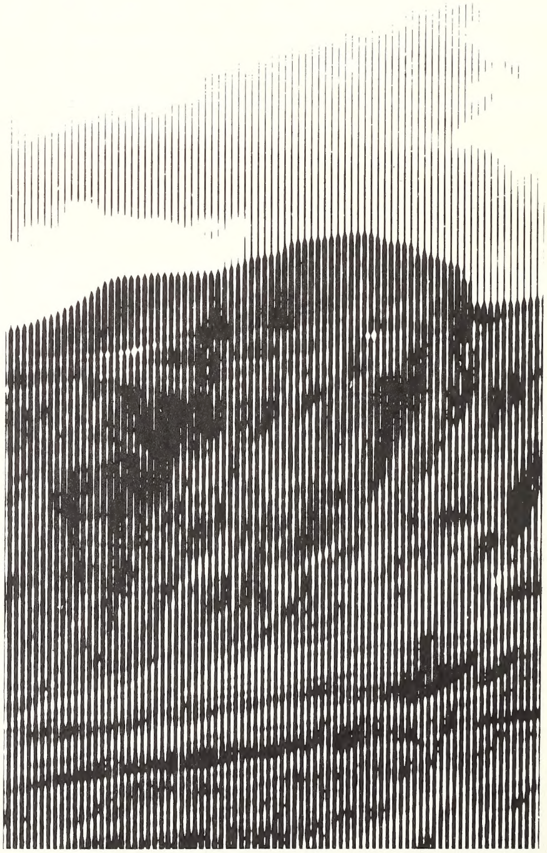
18 What changed the shape of the Mistaya Valley from a "V" to a "U"?

19 Why do glacial lakes such as Peyto Lake change colour throughout the year?

20 What are moraines?

21 How did the last Ice Age affect the plants that lived at that time?

22 About how many years ago did the ice melt from Bow Summit?



Science – process questions

1 **Background information**
The bedrock of Bow Summit consists of limestone and sandstone. It was formed about 500 million years ago. Marine fossils have been discovered in the rock around Bow Summit. The sedimentary rock layers were arched, folded, and thrust upwards.

(a) Recall the layered condition of the many rock faces in the Rocky Mountains. Utilize the knowledge of how a layer cake is made to suggest an explanation for the composition of the bedrock.

(b) Utilize the observation regarding fossils to deduce what lifeforms might have existed in the area 500 million years ago.

(c) What significance would this data have in terms of indicating the probable conditions under which the bedrock was formed?

(d) Consider the shapes of the Rocky Mountains. What do these shapes tell you about their formation?

(e) Organize this data to formulate a theory explaining how a marine fossil could be embedded in rock thousands of metres high.

2 **Background information**
The Mistaya Valley is wide and U-shaped. The Mistaya River runs through the valley. Peyto Glacier lies above the valley. Scientists believe that the Mistaya Valley may once have been a complete arch of rock.

(a) Utilizing your knowledge about the erosive effects of water, speculate how the shape of the Mistaya Valley might have changed from an arch to a "V".

(b) Scientists regard the presence of moraines in the Mistaya Valley as evidence of how far Peyto Glacier once flowed into the valley. Explain the basis for this belief.

(c) Utilize the above data to suggest an explanation for the present "U" shape of the Mistaya Valley.

(d) How could you develop support for your theory in the laboratory?

3 **Background information**
Peyto Lake is fed by meltwater from Peyto Glacier. Small amounts of rock flour in a lake reflect blue-green light, whereas larger amounts reflect green only.

(a) Utilizing the background information, deduce what material is carried into Peyto Lake by the meltwater of Peyto Glacier.

(b) Identify variables which could explain why Peyto Lake has more rock flour in summer than in spring.

(c) Utilizing the background information, predict what the colours of Peyto Lake might be in the spring and summer.

(d) How could you verify this?

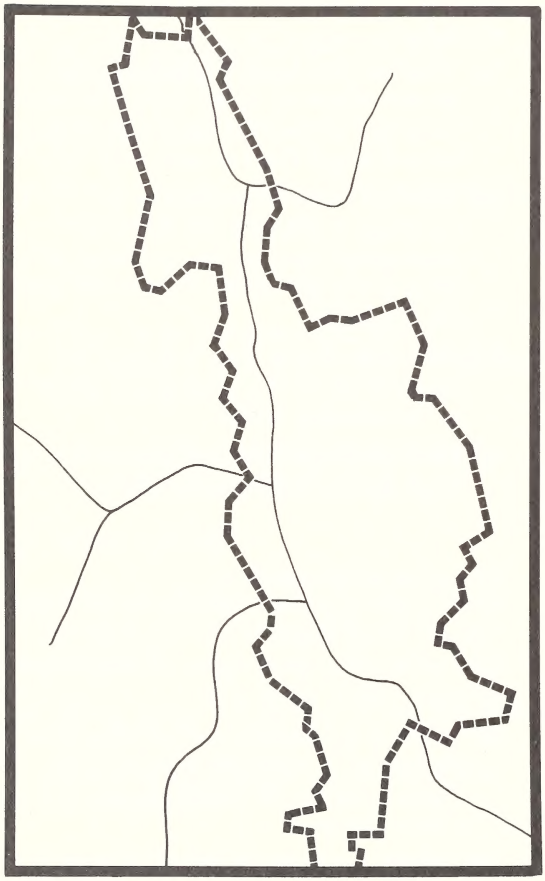
N.B. For approach of questions incorporating science-process skills, see page 6.

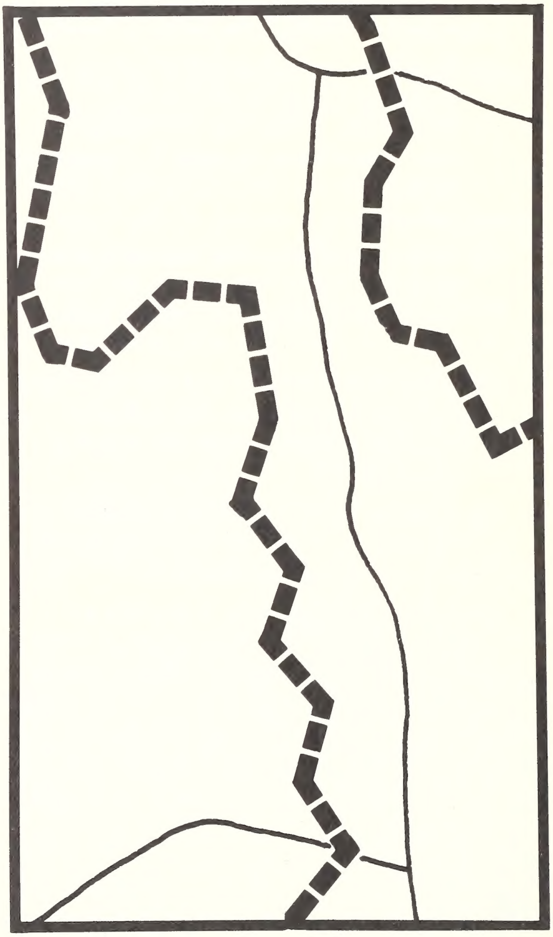
Activity questions

1 Identify the following places:

(a) Banff National Park
Banff
Lake Louise
Bow Pass.

(b) Bow Summit
Mount Thompson
Peyto Glacier
Peyto Lake
the Wapta Icefield.





Activity questions

2 Arrange the following in an order that tells the story of the formation of the Rocky Mountains: layer-cake upthrust; shallow sea over western Canada; Rocky Mountains; sedimentation and compression.

3 Arrange the following in an order that tells the story of the freeze/thaw process: ice in crack; small rock particles; water in crack; crack; rock; ice splitting the rock apart.

4 Draw two pictures which depict Peyto Lake in spring; summer. Explain your pictures.

5 Draw a picture of how you think Bow Summit may have looked during the Ice Age.

6 Draw a picture of how Bow Summit may have looked before the mountains were uplifted.

7 Some of Alberta's most important pioneers are plants. They have leaves instead of hands, and roots instead of feet. At Bow Summit, they live under difficult conditions. If you were a science-fiction artist, how would you paint the pioneer plants of Bow Summit?

8 Choose sides to play charades. Decide what your ground rules are. Act out concepts from Program 1. Don't try to guess the exact words of the charade, just identify the concept. Ideas might come from the following:

(a) Pioneer plants settle in a new area.
(b) A shallow sea once spread over what is now western Canada.
(c) Glaciation changes the shape of a valley from a "V" to a "U".

9 I once stretched over western Canada. I contained plants and marine life. A lot of sand and silt poured into me, making layers. What am I?

10 I am made of rock. I've been part of a glacier. Now I'm suspended in Peyto Lake. What am I?

11 I am made of rock. I've also been part of a glacier. Now I am one of many along the Mistaya Valley. What am I?

12 See how good a detective you are. Underline the seven lies told by this witness, Sedimentary Rock.

I am Sedimentary Rock. I was formed at the bottom of a very deep sea. The sea covered what is now northern Canada. Sand and silt washed into the sea, forming my layers. The weight of these layers created me. Then a great underground force thrust and buckled me high into the air. Water streamed down my sides, cutting a U-shaped valley. With the ice age, glaciers gouged the valley into a V. I still cradle a glacier in one of my valleys. Each summer the sun melts the glacier a bit more, and tiny particles of rock called rock salt are carried out. They flow into a lake called Peyto Lake and give the lake its salty taste. Water, ice, and wind still erode me, making me taller than ever.

Answers to subject questions

1 The colonization of flora through the interaction of landscape and climate

2 Dramatic, as a comparison or analogy

3 They have recently settled in new territory.

4 Forty-three km north of Lake Louise along the Icefields Parkway in Banff National Park

5 About twice as high

6 The shoulder or flank of Mount Thompson, as seen from the self-guiding trail

7 When sand and silt are washed from high land into shallow water, the sediments are deposited into layers and then compressed into rock.

8 Sandstone and limestone

9 The remains or imprints left by plants and animals in rock

10 The bedrock was formed beneath a shallow sea that spread over what is now western Canada about 500 million years ago.

11 A great force from inside the earth. Over a long period of time, the bedrock was thrust up out of the ancient sea, pushed eastward, arched, folded, and cracked.

12 Water and ice

13 When it freezes, it expands and forces the rock to break into smaller particles.

14 Rock particles are carried into streams and rivers. The friction of the particles washing over bedrock cuts "V"-shaped channels.

15 Water erosion

16 Wapta Icefield, Peyto Glacier

17 Icefields are formed when, over thousands of years, more snow falls than melts. The snow compacts into ice.

18 Glaciation

19 Because of the varying amounts of rock flour in them

20 Ridges of boulders and rock debris left behind by a melting glacier

21 Plants survived only in high mountain ranges and in the southern part of the continent.

22 About 7,000 years ago

Answers to science-process questions

Numbers following the answers refer to process skills listed in the inventory on Page 6.

1 (a) Sediments were deposited strata upon strata, like a huge layer cake. (Skills: 3, 4)

(b) Marine life (Skill: 11)

(c) It was formed beneath a shallow sea that spread over what is now western Canada 500 million years ago. (Skill: 11)

(d) A great force from inside the earth thrust the bedrock up out of the ancient sea, pushing it eastward, arching, folding, and cracking it. (Skills: 1, 3, 7, 11)

(e) As a result of sedimentation and compression, the marine fossil became embedded in bedrock. The bedrock was then thrust upwards by a great force from inside the earth. (Skills: 8, 14)

2 (a) A river cut down through the arch, carving a valley with steep, "V"-shaped sides. (Skills: 3, 4)

(b) Moraines are piles of boulders and rock debris left behind by a melting glacier. (Skills: 7, 11)

(c) Glaciers shaped the valley walls into a wide "U". (Skill: 11)

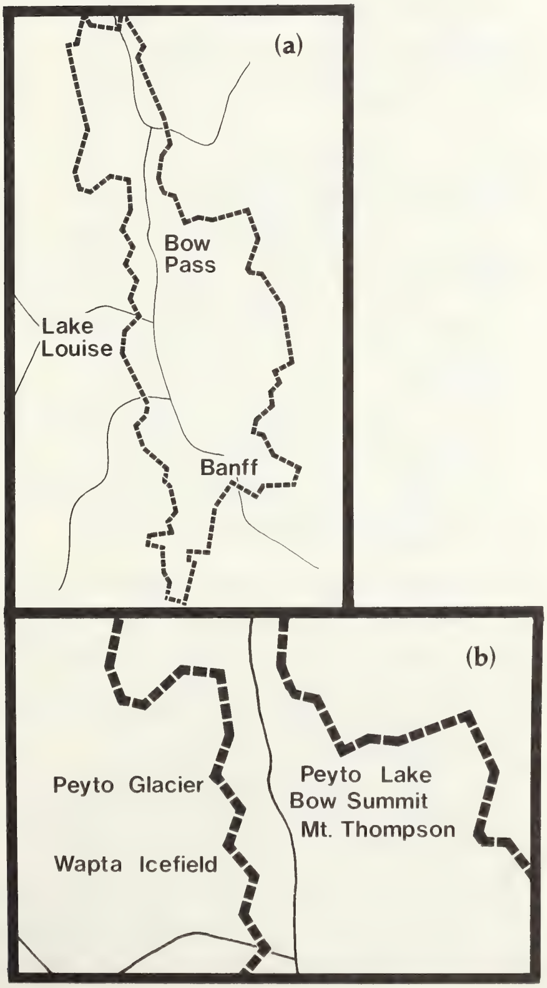
(d) By building a model (Skill: 5)

Answers to Science-process questions

3 (a) Rock flour (Skills: 3, 11)
(b) The warmer temperatures of summer produce more glacial melting, and therefore more rock flour is carried into the lake. (Skills: 1, 4, 11)
(c) Spring – blue-green; summer – green (Skills: 3, 11)
(d) By visiting the lake in the spring and summer (Skills: 5, 7, 11)

Answers to activity questions

1



2 Shallow sea over western Canada; sedimentation and compression; layer-cake upthrust; Rocky Mountains

3 Rock; crack; water in crack; ice in crack; ice splitting the rock apart; small rock particles

4 Spring: when sunlight strikes the clear lake water, blue/green light is reflected and the water looks blue/green.
Summer: rock flour from the melting glacier enters the lake, changing the colour it reflects. Blue light is absorbed and green is reflected.

9 An ancient seabed

10 Rock flour

11 A moraine

12 I am Sedimentary Rock. I was formed at the bottom of a very **deep** sea. The sea covered what is now **northern** Canada. Sand and silt washed into the sea, forming my layers. The weight of these layers created me. Then a great underground force thrust and buckled me high into the air. Water streamed down my sides, cutting a **U-shaped** valley. With the ice age, glaciers gouged the valley into a **V.** I still cradle a glacier in one of my valleys. Each summer the sun melts the glacier a bit more, and tiny particles of rock called **rock salt** are carried out. They flow into a lake called Peyto Lake and give the lake its **salty taste.** Water, ice, and wind still erode me, making me **taller** than ever.

Subject questions

1 What does a plant need from its environment in order to grow?

2 How are the air temperatures at Bow Summit affected by altitude?

3 How might these cooler temperatures affect the growing season and therefore the plants at Bow Summit?

4 Why would the plants of Bow Summit be more affected by ultraviolet radiation than plants at lower altitudes?

5 What are the prevailing winds called that sweep over Bow Summit?

6 Where do these winds originate?

7 Why do these winds pick up speed as they pass through the mountain ranges?

8 What evidence of strong winds is found in the trees at Bow Summit?

9 What affect does the Wapta Icefield have on the air at Bow Summit?

10 Explain the process whereby the western slopes of the Rockies receive more precipitation than the eastern slopes.

11 In what form does most of the precipitation fall at Bow Summit?

12 In what areas at Bow Summit does snow collect?

13 Why is the upper part of Bow Summit usually quite dry?

14 How are soils formed?

15 Why is there so much undecayed plant material in the soil at Bow Summit?

16 How do the soils of the forested slopes differ from the soils above the tree line?

17 Describe the soils of Bow Summit.

Science – process questions

1 **Background information**
Plants must obtain what they need from their environment: energy and warmth come from the sun; rain and snow provide water; the landscape and other plants offer protection from the wind and shelter from the direct rays of the sun.

Utilizing the data given, interpret the common element affecting a plant's environment.

2 **Background information**
Strong cold winds called the westerlies sweep over Bow Summit. These winds gather over the Pacific Ocean, blow across the west coast, through the mountain ranges, over the Wapta Icefield, and down the leeward or eastern slopes of the Rockies.

(a) Why are the prevailing winds at Bow Summit called the westerlies?

(b) Predict what happens to the moisture content of the winds as they blow across the ocean.

(c) Explain what effect the mountain barrier has on the winds.

(d) Utilize this data to formulate a theory as to why Vancouver receives more rain than towns on the eastern slopes of the Rockies.

(e) Analyse the course of these winds to suggest why they are much stronger at Bow Summit than on the west coast.

Science – process questions

(f) Utilize the data from the background information to guess why the breeze blowing over the Bow Summit viewpoint might be cool.

(g) Hypothesize as to why the top of Bow Summit is often free of snow in winter.

(h) The soil at the top of Bow Summit is often dry. Relate this fact to your preceding answer to suggest a reason for this dryness.

3 **Background information**
Scientists have observed that soils are formed when bedrock is weathered into finer particles and plant material decays. Insects help convert plant debris into soil. Few insects survive the harsh climate of Bow Summit. The soil at the top of Bow Summit contains much undecayed plant material. Ice from the last Ice Age left the area only 7000 years ago.

(a) Utilizing the background information, formulate a theory as to why the soil at the top of Bow Summit is coarse.

(b) Utilizing the data concerning the Ice Age, predict whether the soil at Bow Summit is shallow or deep.

(c) Suggest how the soil at Bow Summit might look.

(d) How might you verify this?

4 (a) Calculate the approximate altitude of Bow Summit.

(b) Scientists have found that, at higher altitudes, air expands and grows cooler. What significance might this have in determining the temperature at Bow Summit?

(c) How might you verify this?

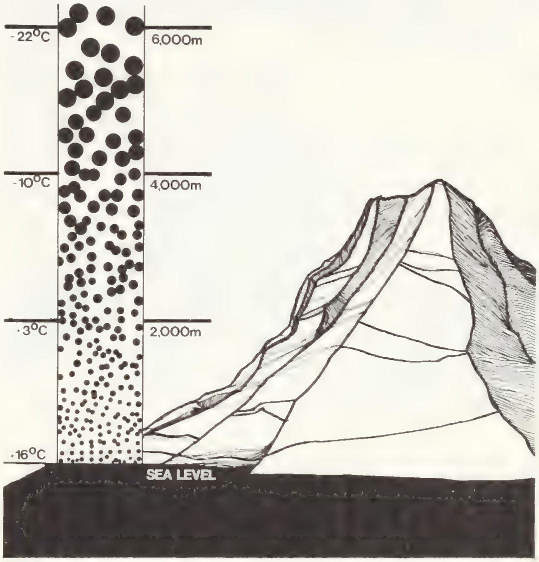
N.B. For approach of questions incorporating science-process skills, see page 6.

Activity questions

1 Pioneer plants travel many miles as seeds. Sketch or paint your own artistic interpretation of this.

2 The thin air at Bow Summit does not screen ultraviolet rays as effectively as does the denser air at lower altitudes. Sketch a cartoon illustrating how this principle might affect visitors to Bow Summit.

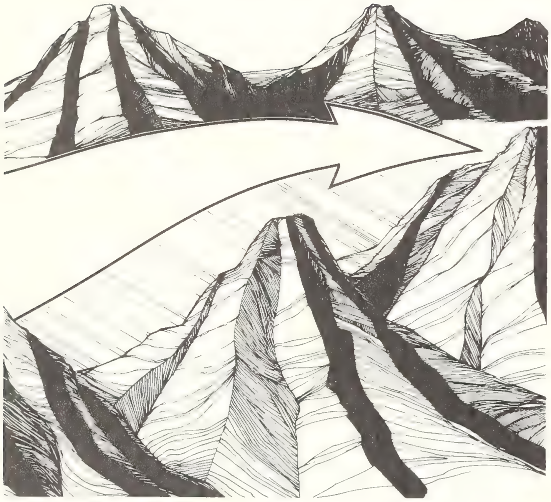
3 Draw a humourous sketch or series of sketches illustrating this statement:
Snow flurries can occur at Bow Summit even in July.



4 Describe the principle illustrated in this graph. How does it help explain the cool air of Bow Summit?

Activity questions

5 The picture below illustrates one way in which mountain ranges affect winds which blow through them. Describe the effect.



6 Study the picture below and explain why Vancouver receives more rain than towns on the eastern slopes of the Rockies.

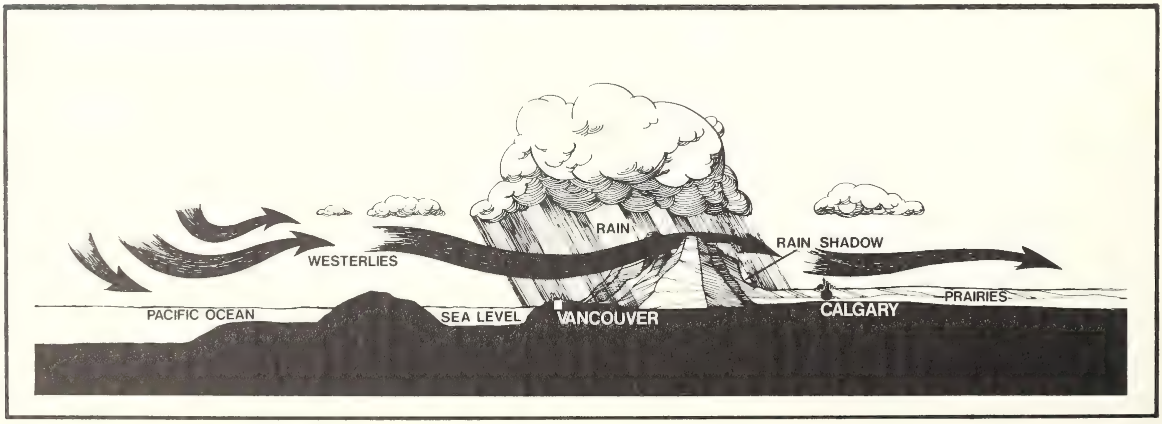
7 Choose sides to play charades. (See Program 1 – Activity Question #8.) Ideas might come from the following:
- (a) Plants need shade from the direct rays of the sun.
- (b) At high altitudes air expands and grows cooler.
- (c) Snow flurries can occur even in July.
- (d) The soil at Bow Summit is coarse and acidic.

8 If you're not careful, I can make you very sore. I also damage plants. At high altitudes, I am very intense. What am I?

9 I convert plant debris into soil. I have difficulty living in the cold at Bow Summit. What am I?

10 See how discerning a lawyer you are. Expose the four lies told by these witnesses:

We are the Westerlies, the winds that blow over Bow Summit. We originate in the Atlantic Ocean. The Rocky Mountains act as a funnel when we blow through them. This slows us down. When we blow across the Wapta Icefield, the wide expanse warms us up. We blow so hard that some of the trees on Bow Summit point their branches in the direction we blow. These trees are called pom-pom trees.



Answers to subject questions

1 Energy, warmth, minerals, water, protection from wind, shade from the sun, soil

2 (a) At high altitudes, air expands and grows cooler.
(b) Bow Summit is located along the continental divide of the Rocky Mountains.

3 The temperatures result in a shorter growing season for the plants.

4 The thin air at high altitudes doesn't screen ultra-violet rays as well as the denser air at lower altitudes.

5 The westerlies

6 Over the Pacific Ocean

7 The mountain ranges funnel them.

8 The trees are bent and crooked.

9 The air is cooled as it blows across the Icefield.

10 When the westerlies meet the mountain barrier they rise, and their moisture condenses, falling as rain or snow. As they cross the mountain ranges, they lose their moisture and descend the eastern slopes bearing little precipitation.

11 As snow

12 In hollows and around trees on the lower and middle parts of the slope

13 Strong winds blow the snow away and dry the ground.

14 By the weathering of bedrock into finer particles and the decaying of plant and animal materials

15 Few insects that convert plant debris into soil can survive the cold temperatures.

16 Soils of the forested slopes have more plant material and are finer in texture.

17 They are acidic and coarse in texture.

Answers to science-process questions

Numbers following the answers refer to process skills listed in the inventory on Page 6.

1 Climate (Skill: 11)

2 (a) They come from the west. (Skill: 2)
(b) It increases as they pick up moisture evaporating from the water. (Skill: 3)
(c) The mountain barrier causes the winds to rise. (Skill: 4)
(d) When the westerlies meet the mountain barrier they rise, and their moisture condenses, falling as rain or snow. As they cross the mountain ranges, they lose their moisture and descend the eastern slopes bearing little precipitation. This creates a rainshadow effect on the eastern slopes. (Skills: 8, 14)
(e) The ranges funnel the winds so that they pick up speed. (Skills: 3, 8, 14)
(f) (1) The air at high altitudes is cool.
(2) As the westerlies blow across the Wapta Icefield, they are cooled. (Skills: 8, 14)
(g) The winds blow the snow away. (Skill: 4)
(h) Because melting snow provides most of the water at Bow Summit, the upper part of the slope is usually quite dry. (Skills: 8, 14)

Answers to science-process questions

3 (a) Only a few insects that convert plant debris to soil can survive the cold temperatures. (Skills: 8, 14)

(b) Shallow, as ice from the Ice Age left the area only 7000 years ago. It would take many years to develop soils in the harsh climate of Bow Summit. (Skill: 3)

(c) Coarse, with large particles (Skill: 3)

(d) Visit Bow Summit (Skill: 5)

4 (a) Approximately 2068 m (Skill: 3)

(b) The temperature at Bow Summit should be cool because Bow Summit is at a high altitude.

(c) Visit Bow Summit

Answers to activity questions

4 At high altitudes, air expands and grows cooler.

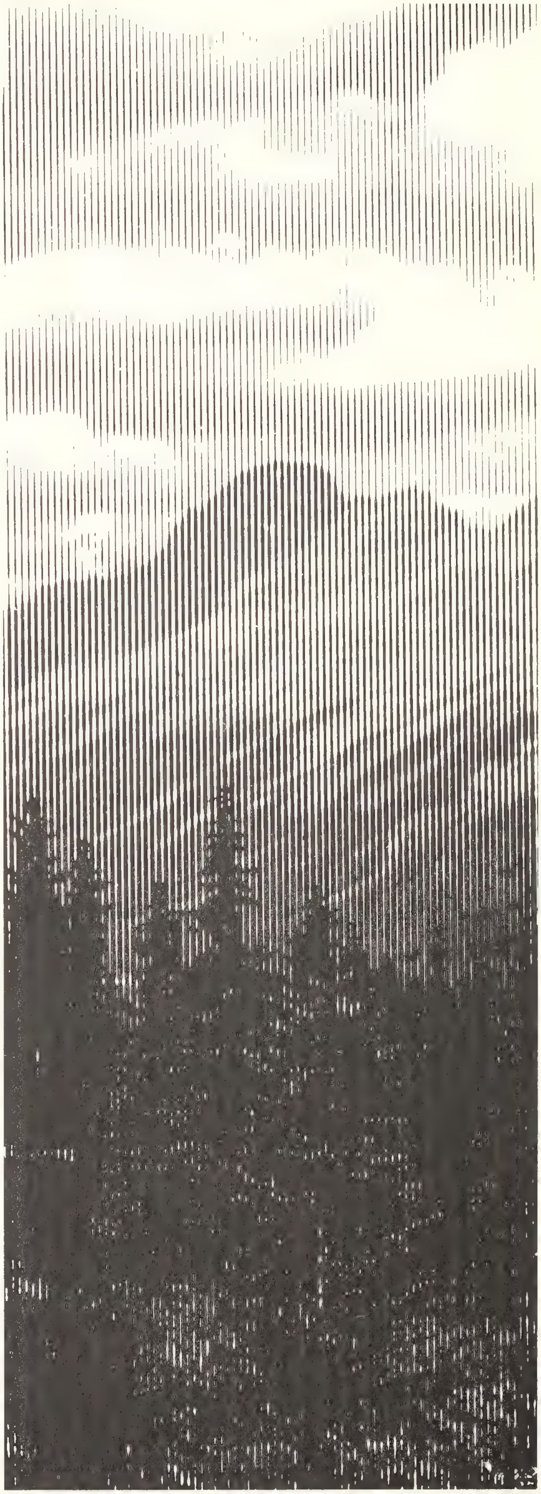
5 Funnelling

6 When the westerlies meet the mountain barrier they rise, and their moisture condenses, falling as rain or snow. As they cross the mountain ranges, they lose their moisture and descend the eastern slopes bearing little precipitation. This creates a rainshadow effect on the eastern slopes.

8 Ultraviolet rays

9 An insect

10 We are the Westerlies, the winds that blow over Bow Summit. We originate in the **Atlantic Ocean.** The Rocky Mountains act as a funnel when we blow through them. **This slows us down.** When we blow across the Wapta Icefield, the wide expanse **warms us up.** We blow so hard that some of the trees on Bow Summit point their branches in the direction we blow. These trees are called **pom-pom trees.**



BOW SUMMIT PROGRAM 3

Subject questions

1 What is meant by the descriptive phrase "vegetation pattern"?

2 Name the three zones of vegetation on Bow Summit.

3 Where do each of the three vegetation zones occur?

4 Describe the characteristics of the needles and cones of Englemann spruce.

5 Describe the characteristics of the needles and cones of subalpine fir.

6 Describe a tree island.

7 As we walked higher along the slopes of Bow Summit, what species of tree was most common?

8 What does "krummholz" mean?

9 Why are the trees on the upper slopes dwarfed and crooked?

10 The tree line is the broad area where the forest gradually breaks up into alpine meadows. Why is this broad area called "tree line"?

11 Suggest factors that influence the elevation of a tree line.

12 Name two shrubs growing in the tree line area.

13 Describe the appearance of the alpine landscape.

14 Describe the types of plants in the alpine zone.

15 What plant resembles splashes of colour on the rocks?

16 What is usually the first plant to settle in a new area?

17 What are the two overall factors which produce the vegetation pattern of Bow Summit?

Science – process questions

1 **Background information**
Be a science detective. Your mission is to make observations and interpret data. The vegetation pattern of Bow Summit has three zones:

(a) The heavily forested subalpine zone occurs on the lower slopes of the mountain.

(b) The tree-line zone is the area of transition between the subalpine and alpine zones. Up close it appears as a broad area in which the forest gradually thins out to clearings filled with shrubs.

(c) The alpine zone occurs on the higher slopes of the mountain. In the meadows, the vegetation does not have the protection of trees, and the uppermost area is open and rocky.

From the data given above, predict in which of the three zones of Bow Summit the following are most common: dense forest, broad area where forest opens into clearings, Englemann spruce, cushion plants growing in the shelter of rocks, shrubs such as heather and bearberry, open meadows with low-growing plants, trees with "skirts" of low, shrubby branches, trees with needles and cones, subalpine fir, tree islands (clumps of trees surrounded by low vegetation), lichens on high, rocky ridges.

Science – process questions

2 **Background information**
The elevation of a tree line varies depending on the nature of the slope. In the following examples, utilize this observation to predict whether you think the tree line would be high or low, and explain your reasoning.

(a) A tree line lies below loose gravel and shale where an avalanche has occurred.

(b) A tree line occurs on a south-facing slope, exposed to sun and wind.

3 **Background information**
The tree line is the broad area where the forest gradually breaks into alpine meadows.

(a) Describe the appearance of a tree line when seen from a distance of several miles.

(b) Describe the appearance of a tree line when seen from within it.

(c) Describe where the subalpine zone occurs.

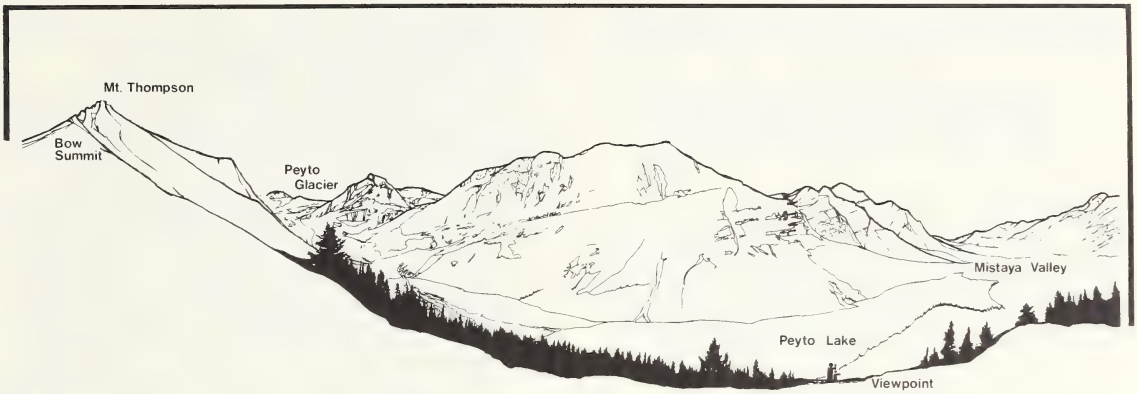
(d) Describe where the alpine zone occurs.

(e) Utilizing your preceding statements, describe how distance changes perception with regard to the separation of vegetation zones at Bow Summit.

(f) Formulate an operational definition of a tree line.

N.B. For approach of questions incorporating science-process skills, see page 6.

BOW SUMMIT PROGRAM 3



Activity questions

1 Sketch your own self-guiding trail up Mount Thompson. Identify the three vegetation zones. See how many of the following you can correctly place:
dense forest, broad area where forest opens into clearings, Englemann spruce, cushion plants growing in the shelter of rocks, shrubs such as heather and bearberry, open meadows with low-growing plants, trees with "skirts" of low, shrubby branches, trees with needles and cones, subalpine fir, tree islands (clumps of trees surrounded by low vegetation), lichens on high, rocky ridges.

2 Sketch a picture of a subalpine environment.

3 Paint a picture showing lichen in the alpine zone at Bow Summit.

4 You are having a dream about elfin wood, trees shaped like elves or dwarfs.
Paint or sketch your dream.

5 Sketch or paint a tree line from a distance and from close-up.

6 Identify these alpine plants.
_____________ has tiny spirals of needle-like leaves and flowers like miniature bells;
___________ carpets the ground with shiny leaves and tiny red berries.

7 Match these characteristics to either Englemann spruce or subalpine fir: four-sided needles, flat needles, cones that stand up, cones that hang down.

8 You are a lawyer cross-examining the witness, Tree line. Underline the six lies:

I am Tree line at Bow Summit. My name is used to describe one of the zones there. Below me is the zone called subalpine. It is a forest containing Englemann spruce, cushion plants, and whitebark pine. Above me is the zone called alpine. It, too, is heavily forested. It also contains meadows. Strong cold winds blow in the alpine zone. This leaves the soil there moist. I am called tree line because the trees end abruptly where I am. This forms a distinct line when you're up close. I occur at the same altitude on all mountains.

9 Where I grow, there are icy winds and little moisture. No other plant can survive here. I am the first pioneer to settle in a new area. What am I?

10 When you're far away I look like a line.
But up close I'm hard to define.
What am I?

Answers to subject questions

1 When several large communities of plants are adjacent to each other, they form a pattern when viewed from a distance.

2 Subalpine, tree line, and alpine

3 The subalpine zone is on the lower part of the slope. The alpine zone is on the higher part of the slope, and the area where these two zones meet is called the tree line.

4 The needles are four-sided, and the cones hang down from the branches.

5 The needles are flat, and the cones stand up on the branches.

6 A clump of trees surrounded by low vegetation

7 Subalpine fir

8 It is a German word meaning "crooked wood."

9 The cold, strong winds have bent and twisted them.

10 It looks like a sharp line when viewed from a distance.

11 The amount of wind and moisture and the stability of soils and snow

12 Heather, bearberry

13 Meadows, hummocks, rocky ridges, and moist hollows

14 Low-growing non-woody plants, mosses, grasses, and lichens

15 Lichen

16 Lichen

17 Landscape and climate

Answers to science-process questions

Numbers following the answers refer to process skills listed in the inventory on Page 6.

1 Subalpine: dense forest, Englemann spruce, subalpine fir, trees with needles and cones; tree line: broad area where forest opens into clearings, tree islands, trees with skirts of low, shrubby branches, shrubs such as heather and bearberry; alpine: lichens on high rocky ridges, open meadows with low-growing plants, cushion plants growing in the shelter of rocks. (Skills: 1, 3, 8, 9, 11)

2 (a) Lower, because the avalanche has pushed the trees down the slope

(b) Lower, because there isn't adequate moisture for the trees to occur high on the slope

3 (a) A sharp line where the forest ends (Skill: 2)

(b) A broad area with clumps of trees, shrubs, and patches of meadow (Skill: 2)

(c) It occurs low on the slopes, below the tree line. (Skill: 2)

(d) It occurs high on the slopes, above the tree line. (Skill: 2)

(e) From a distance the dividing line between alpine and subalpine seems sharp and definite. Up close there is no definite line, but only a gradual lessening of trees. (Skills: 8, 14)

(f) The tree line is the broad area where the forest gradually breaks into alpine meadows. It looks like a line when viewed from a distance. (Skill: 12)

Answers to activity questions

1 Subalpine: dense forest, Englemann spruce, subalpine fir, trees with needles and cones; tree line: broad area where forest opens into clearings, tree islands, trees with skirts of low, shrubby branches, shrubs such as heather and bearberry; alpine: lichens on high rocky ridges, open meadows with low-growing plants, cushion plants growing in the shelter of rocks.

6 Heather; bearberry

7 Englemann spruce: four-sided needles, cones that hang down; subalpine fir: flat needles, cones that stand up.

8 I am Tree line at Bow Summit. My name is used to describe one of the zones there. Below me is the zone called subalpine. It is a forest containing Englemann spruce, **cushion plants,** and whitebark pine. Above me is the zone called alpine. **It, too, is heavily forested.** It also contains meadows. Strong cold winds blow in the alpine zone. This leaves the soil there **moist.** I am called tree line because the trees end **abruptly** where I am. This forms a distinct line **when you're up close. I occur at the same altitude** on all mountains.

9 Lichen

10 A tree line

Subject questions

1 "Few plants can survive in the high alpine. There, plants are environmentally selected by the severity of the climate". What does this statement mean?

2 Why are the leaves of subalpine fir and Englemann spruce needle-like and waxy?

3 Circle the tree that is better adapted to growing in the colder and stronger winds of the tree-line zone: Englemann spruce, subalpine fir, whitebark pine.

4 How are subalpine fir needles adapted to take advantage of the insulation provided by snow?

5 How is the sap of subalpine fir better adapted to cold temperatures than the sap of Engleman spruce?

6 At the tree line, subalpine firs look like shrubs. How is this an adaptation?

7 What are shrub-like colonies of subalpine fir called?

8 These colonies grow close to the ground and in hollows where snow collects. Why?

9 Why is the central tree of a tree island the tallest?

10 Why do the branches of flag trees point in the direction the wind is blowing?

11 "By growing low and close together, mat plants create a layer of undisturbed air next to the ground." Explain how this grouping protects the plants.

12 How are cushion plants different from mat plants?

13 Why are temperatures warmer close to the ground?

14 How has heather adapted to make use of the warmer temperatures close to the ground?

15 What is a perennial?

16 How might perennials be better adapted to the alpine environment than annual plants, which live only one year?

17 Why are the roots of an alpine perennial deep and thick?

18 Why do some perennials have pre-formed shoots and flower buds?

19 Alpine perennials may exhibit slow growth by taking two or three years to flower. How is this an adaptation?

20 Relative to their size, alpine plants have flowers that are large and colourful. Why?

21 Saxifrage grows in rock crevices. How is its use of this location an adaptation?

22 Moss grows in hollows where snow lingers. Why?

23 White mountain avens has tiny hairs on its stem. Why?

24 Explain why many plants in the alpine zone have needle or scale-like leaves.

25 Why is the root system of moss campion so deep?

26 What plant survives on the highest slopes of Bow Summit where there is little moisture?

27 How does the red colour in the leaves and stems of some alpine plants provide a protective adaptation?

28 Identify one adaptation that is large in size and one that is small.

BOW SUMMIT
PROGRAM 4

Science – process questions

1 This is a science detective exercise. Some key scientific observations are listed below:

- (a) Subalpine fir and Englemann spruce have adapted to the harsh climate of Bow Summit.
- (b) The wind is frequently strong and drying at Bow Summit.
- (c) The wind often blows the high ridges free of moisture-giving snow. This dries the soil.
- (d) Trees and plants group together for protection from the wind.
- (e) Plants growing close to the ground take advantage of the warmer air temperatures there.
- (f) Most plants in the alpine zone are perennials.

By using the above clues, predict relationships by matching the word or phrase from the left column with the appropriate selection from the right column. Use all the choices.

1 Plants are environmentally selected by . . .	(a) . . . has needles that are clustered on top of its twigs to catch insulating snow.
2 Snow . . .	(b) . . . has thick sap to prevent it from freezing.
3 Mat plants create a layer of undisturbed air next to the ground. This reduces . . .	(c) . . . provides insulation for plants.
4 Subalpine fir . . .	(d) . . . plant tissues from the wind.
5 The central tree in a tree island always grows tallest because . . .	(e) . . . protection from the wind.
6 White mountain avens has tiny hairs on its stem. These shield . . .	(f) . . . the impact of the wind, and warms the air inside the group of plants.
7 Saxifrage hides in rock crevices; this micro-environment offers . . .	(g) . . . the severity of the climate.
8 Subalpine fir . . .	(h) . . . its base is the most protected.
9 Arctic willow has adapted to take advantage of the warmer temperatures close to the ground; it is . . .	(i) . . . moisture.
10 Heather has also adapted to take advantage of the warmer air close to the ground. Its buds . . .	(j) . . . are groups of low, shrubby trees.
11 Englemann spruce and subalpine fir . . .	(k) . . . a mat plant.
12 Perennials are plants that live for many years. In this way, they . . .	(l) . . . grow at the base of the plant near the soil surface.
13 In winter, particles of ice and snow driven by wind scour the exposed side of flag trees. This prevents . . .	(m) . . . have needle-like leaves covered with wax to conserve moisture.
14 Moss lives in hollows where snow lingers; the snow provides . . .	(n) . . . store energy from year to year.
15 White mountain avens forms low-spreading carpets; it is an example of . . .	(o) . . . only four inches (10 cm) tall.

Science – process questions

16 Krummholz colonies . . .

17 Moss campion grows in low domes; it is an example of a . . .

18 Moss campion has developed a deep root system in search of . . .

19 Some perennials have adapted by growing quickly in a short growing season; they have . . .

20 Perennial plants may exhibit slow growth by taking . . .

21 Flag trees have . . .

22 Many plants in the alpine zone have needle or scale-like leaves. This small surface area lessens . . .

23 Relative to their size, alpine plants have flowers that are large and colourful; this is because the growing season is short and they quickly attract . . .

(p) . . . the growth of branches on the windward side.

(q) . . . the amount of moisture lost to the air.

(r) . . . two to three years to flower.

(s) . . . cushion plant.

(t) . . . pollinating insects.

(u) . . . pre-formed shoots and flower buds.

(v) . . . moisture.

(w) . . . branches that primarily point in the direction the wind is blowing.

N.B. For approach of questions incorporating science-process skills, see page 6.

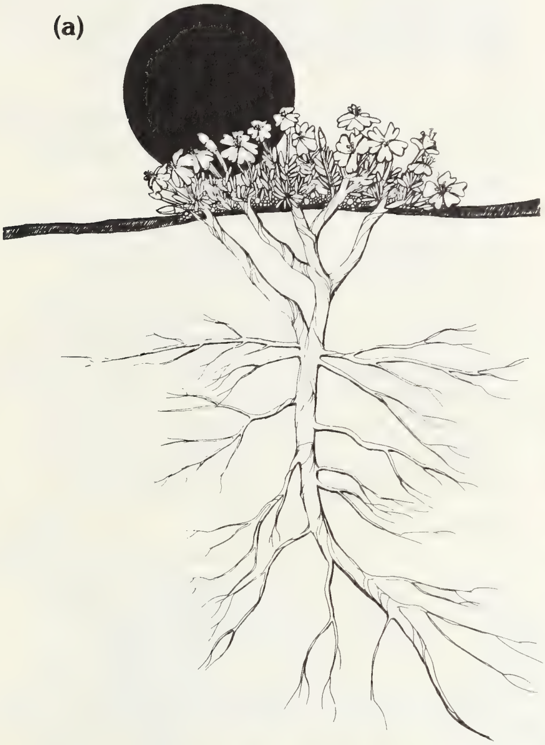
BOW SUMMIT PROGRAM 4

Activity questions

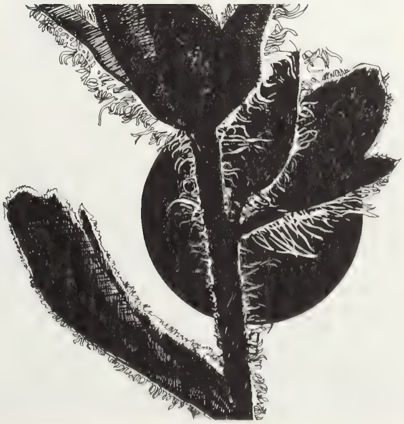
1 Sketch the following hardships with which plants at Bow Summit must contend: high precipitation, ultraviolet radiation, and strong, cold winds.

2 Identify the adaptations illustrated in these pictures. (a-d)

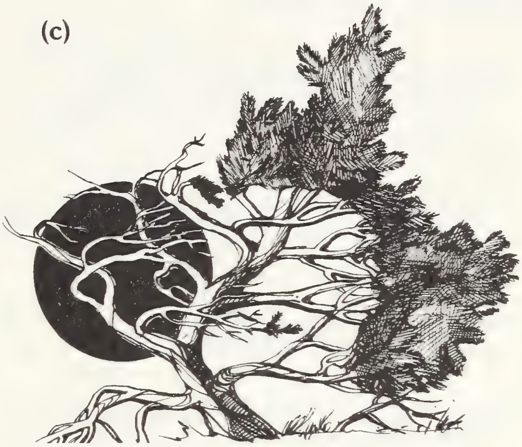
(a)



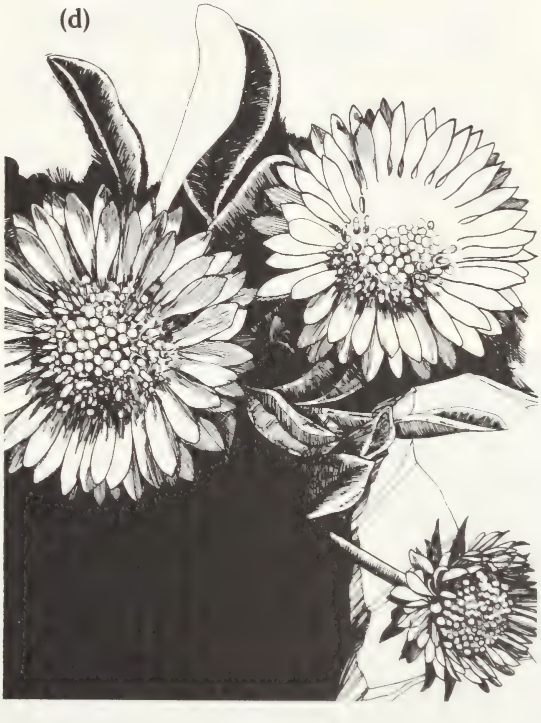
(b)



(c)



(d)



Activity questions

3 Think back over human evolution. Discuss how humans have adapted to their environment. Are there any similarities to plant adaptations?

4 Debate whether humans or plants have adapted more successfully to high mountain life.

5 Write an adventure story about the adaptations of an alpine plant.

6 We grow close together, creating a layer of undisturbed air next to the ground. This reduces the impact of the wind. We are attached by root branches to a single tap root. What are we?

7 We also grow close together for protection from the wind. Our central tree is tallest because its base is the most protected. What are we?

8 You are a top lawyer called in to cross-examine the witness, Krummholz. Identify the four lies told by Krummholz.

I am Krummholz. My name comes from the Spanish language. It means "close to the ground". Some subalpine fir grow in the form of krummholz colonies. They look more like shrubs than trees. They grow close to the ground so that the earth's moisture will have less distance to travel up their trunks. Sometimes they grow in hollows where snow collects; this helps camouflage them from winter animals.

9 You are a newspaper reporter. Perennial, the person you are interviewing, is telling four lies. Spot those lies and win a commendation from the Boss.

I am Perennial. I store energy for one season only. The energy is stored in my flowers. My roots are thick and deep. In this way, no one can pull me out of the ground. Some of us have pre-formed shoots and buds, which flower as soon as the snow is gone. This way, we get a headstart on a short growing season. My friend, the annual plant, lives for many years.

Answers to subject questions

1 Only those plants that adapt to the severe climate can survive.

2 To conserve moisture

3 Englemann spruce, subalpine fir, whitebark pine.

4 The needles are upturned to collect snow. Snow protects the plant tissues from the cold and wind.

5 It is thicker and therefore will not freeze as easily.

6 The reduction in height and broadening of width is an adaptation to the severe temperatures and extreme winds.

7 Krummholz colonies

8 For protection from the cold. Snow insulates against temperature extremes: low in the winter, and high in the bright sun of early spring.

9 Its base is the most protected.

10 In winter, particles of ice and snow driven by the wind scour the exposed side of the trunk. This prevents the growth of branches on the windward side.

11 It reduces the impact of the wind and moderates the temperatures inside the mat.

12 Cushion plants are more compact and are attached by root branches to a single tap-root; mat plants have individual tap-roots.

13 The earth re-radiates heat from the sun, while irregularities in the ground slow the speed of the wind. This reduces heat loss.

14 Its buds are protected at the base of the plant, near the soil surface.

15 A plant that lives for many years

16 Perennials can store energy from year to year.

17 The roots store many nutrients, which help the plant grow quickly in the spring.

18 They take a running start at a short season by flowering as soon as the snow is gone.

19 The perennials store energy while they wait to bloom in a season with good growing conditions.

20 They must quickly attract the attention of pollinating insects in the short growing season.

21 The rock crevice protects it from the wind.

22 The melting snow provides moisture.

23 They shield the tissues from the wind.

24 Because the surface area of these leaves is small, less moisture is lost to the air.

25 The roots grow deep searching for moisture.

26 Lichen

27 Red-coloured chemicals block the damaging ultraviolet radiation.

28 A tree island; the tiny hairs on a stem.

Answers to Science-process questions

Numbers following the answers refer to process skills listed in the inventory on Page 6.

1 1-g; 2-c; 3-f; 4-a, b; 5-h; 6-d; 7-e; 8-a, b; 9-o; 10-l; 11-m; 12-n; 13-p; 14-i; 15-k; 16-j; 17-s; 18-v; 19-u; 20-r; 21-w; 22-q; 23-t. (Skills: 1, 3, 8, 9, 11)

Answers to activity questions

2 (a) Roots of a perennial; store many nutrients, which help the plant grow quickly in the spring.

(b) Tiny hairs on a stem; shield the tissues from the wind.

(c) Plants growing together for protection from the wind.

(d) Large flowers; alpine plants must quickly attract pollinating insects in the short growing season.

6 Cushion plants

7 Tree islands

8 I am Krummholz. My name comes from the **Spanish** language. It means "**close to the ground**". Some subalpine fir grow in the form of krummholz colonies. They look more like shrubs than trees. They grow close to the ground so that **the earth's moisture will have less distance to travel up their trunks.** Sometimes they grow in hollows where snow collects; this helps **camouflage them from winter animals.**

9 I am Perennial. I store energy **for one season only.** The energy is stored **in my flowers.** My roots are thick and deep. In this way, no one can **pull me out of the ground.** Some of us have pre-formed shoots and buds, which flower as soon as the snow is gone. This way, we get a headstart on a short growing season. My friend, the annual plant, **lives for many years.**

BOW SUMMIT PROGRAM 5

Subject questions

1 Name one animal and one bird that live at Bow Summit.

2 What are the two major forces that eroded the landscape of Bow Summit?

3 Approximately how long have people been involved in the fragile relationship between plants and their environment at Bow Summit?

4 What has been the impact on the vegetation where people have strayed from the trails at Bow Summit?

5 What do the signs and brochure explain about the Bow Summit area?

6 Sometime ago, Parks Canada began a project to enable visitors to view Bow Summit without causing further damage to its beauty. Name three things that were part of that project.

7 What are Parks Canada's two goals for Bow Summit?

8 What environments does Bow Summit represent?

9 Bow Summit is just one of many areas in the Rocky Mountains where alpine and subalpine meet. At least seven other similar areas exist. Identify two.

Science – process questions

1 **Background information**
Parks Canada has two goals for Bow Summit: to help visitors understand and appreciate its natural beauty; and to protect and preserve a natural area of Canada.

(**a**) Utilizing this information, predict the broad objective of Parks Canada for all national parks.

2 **Background information**
The climate of Bow Summit consists of a short growing season, harsh winters, cold temperatures, strong winds, and heavy snowfalls.

(**a**) Utilize these facts to predict the effect of climate on the vegetation of Bow Summit.

(**b**) The colonization of plants on Bow Summit has been slow and difficult. What significance does this have in terms of damage done by visitors?

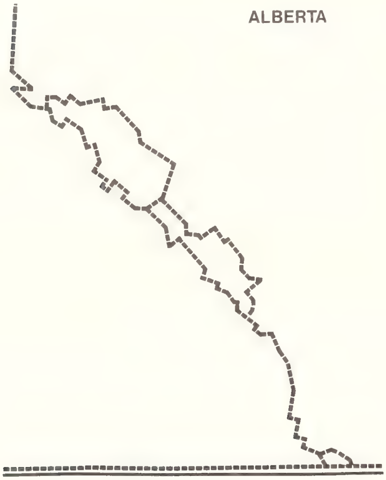
3 **Background information**
As part of Parks Canada's project at Bow Summit, trails were paved and clearly marked. Vegetation was transplanted, and signs and a brochure were produced.

Predict the probable reasoning behind each action.

N.B. For approach of questions incorporating science-process skills, see page 6.

Activity questions

1 The following national parks in Alberta have alpine/subalpine environments: Banff National Park, Jasper National Park, and Waterton Lakes National Park. Locate and colour them on a map.



2 In these programs, the vegetation of Bow Summit has been compared to pioneers. Draw a series of sketches depicting plants as pioneers.

3 When the highway was built over Bow Pass, thousands of people were able to visit Bow Summit. Consider the fragility of the Bow Summit area and people's desire to enjoy nature. Debate the negative and positive aspects of having access to the Bow Summit area.

4 Discuss how you and other visitors to our national parks can assist Parks Canada in implementing its two goals for Bow Summit:

(a) to help visitors understand and appreciate its natural beauty, and

(b) to protect and preserve a natural area of Canada.

5 (a) Identify the damage caused by visitors.

(b) Identify the steps taken by Parks Canada to protect the Bow Summit area.

(a)

(b)

Answers to subject questions

1 Animals: marmots, pikas, golden-mantled ground squirrels; birds: ptarmigan, Gray Jays

2 Water and ice

3 About 200 years

4 Vegetation has been worn away.

5 They interpret the area and discuss its fragility.

6 Trails have been paved and clearly marked, clumps of vegetation have been transplanted to eroded areas, signs and a brochure explain the fragility of the area

7 To help visitors understand and appreciate its natural beauty; and to protect and preserve a natural area of Canada

8 The alpine and subalpine environments of the Rockies

9 Sulphur Mountain, Plain of Six Glaciers, and Parker Ridge in Banff National Park; Mount Edith Cavell, the Whistlers, and the Bald Hills in Jasper National Park; and Cameron Lakes in Waterton Lakes National Park

Answers to Science-process questions

Numbers following the answers refer to process skills listed in the inventory on Page 6.

1 (a) The broad objective of Parks Canada for national parks is:

> "To protect for all time representative natural areas of Canadian significance in a system of national parks, and to encourage public understanding, appreciation and enjoyment of this natural heritage so as to leave it unimpaired for future generations."
>
> Parks Canada Policy, 1979 (Skills: 3, 4)

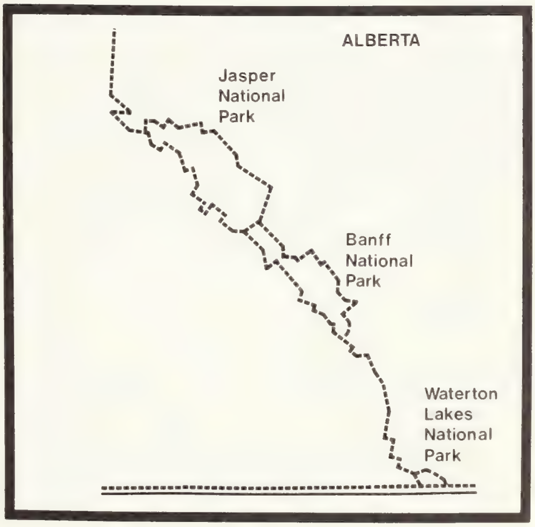
2 (a) The plants must struggle to survive in the harsh environment. (Skill: 3)

(b) It takes many years to repair damage. (Skills: 3, 4)

3 To encourage people to stay on the trails, to replace damaged vegetation, and to interpret the area and explain its fragility (Skills: 3, 4)

Answers to activity questions

1



5 (a) The vegetation has been worn away where people have strayed from the trails.

(b) Paved and clearly marked trails, transplanted vegetation, signs and a brochure explaining the fragility of the area

AND AT THE BACK

...a review test covering all five programs in the series

Match the word or phrase from the left column with the most appropriate selection from the right column. Use all the choices.

1 Millions of years ago western Canada was covered by...
2 Sediments were compressed into rock by...
3 The Rocky Mountains were formed by...
4 Thrusting, arching, and folding are aspects of...
5 Two important agents of erosion are...
6 Once, glaciers and ice sheets covered all but...
7 Glacial lakes change colour because of...
8 The air is cool at Bow Summit because...
9 At Bow Summit the growing season is...
10 You can see evidence of the strong winds at Bow Summit in...
11 At Bow Summit, snow flurries can occur in...
12 The soil at Bow Summit is coarse because...
13 In the subalpine zone...
14 In the tree-line zone...
15 In the alpine zone...
16 Subalpine fir has needles that are clustered on top of the twig to catch...
17 Some alpine plants group together to gain protection from...
18 Some alpine plants have leathery leaves to prevent...
19 Alpine flowers are large and colourful to attract...
20 Bow Summit is just one area in the Rocky Mountains that tells the story of...
21 One goal of Parks Canada is to preserve and protect...

a ...the highest peaks of the Rocky Mountains.
b ...mountain building.
c ...the amount of rock flour they contain.
d ...an ancient sea.
e ...the weight of many layers.
f ...underground forces that thrust rock up from the floor of an ancient sea.
g ...water and ice.
h ...few insects that break down plant debris can survive the cold temperatures.
i ...July.
j ...at high altitudes air expands and becomes cooler.
k ...the bent and crooked trees there.
l ...very short.
m ...only low vegetation grows.
n ...dense forests grow.
o ...the forest gradually opens into meadows.
p ...moisture loss.
q ...pollinating insects in the short growing season.
r ...the wind.
s ...the insulating snow.
t ...natural areas.
u ...the tree-line.

Series Test – Answers

1-d; 2-e; 3-f; 4-b; 5-g; 6-a; 7-c; 8-j; 9-l; 10-k; 11-i; 12-h; 13-n; 14-o; 15-n; 16-s; 17-r; 18-p; 19-q; 20-u; 21-t.

SCIENCE PROCESSES:

The Basis of Problem Solving

Gary Gay, Ph.D.

Process instruction is based on the premise that the behavior of scientists can be analyzed into simple activities and that these can be arranged in a coherent, logical set. Processes, then, are the activities that scientists exhibit in their research or problem solving behavior. As such, processes form the basis of problem solving, inquiry, investigating, experimenting, research projects or any similar activity. Although many sets of process skills exist, a system should be used that exhibits two main characteristics: 1) it is a valid list of activities representing scientific investigative behavior and 2) a structure or logical order is evident in the list. (Note: this order is not necessarily linear).

Many educators subscribe to an activity approach in science; this is frequently **not** a process approach. In a process approach classroom activities must continuously be analyzed with the students relative to 1) what process skills are involved and 2) the specific problem solving functions of the processes. Also, a variety of pedagogical techniques should be used to illustrate utilization of the process skills. These techniques may include lectures, movies, investigations, etc.

Several pedagogical components of the process approach should be considered by the teacher. Behavioral objectives exist and can be produced for teaching process skills; these help create evaluation ideas as well as instructional outcomes. Teaching of the process skills should be incorporated into inquiry-oriented lesson and unit plans. In inquiry-oriented instruction, attention should be paid to teaching the process skills **and** to giving the students opportunities to practice these skills.

After experiencing a process approach, students should understand several basic concepts relative to processes. 1) Process skills form a logical, coherent structure. They are not random. 2) Process skills form the basis for a problem solving strategy that can be used in all aspects of life (i.e. they are integrative). 3) We live in a world of rapid change; process skills provide a mechanism for dealing with this reality, and 4) an investigation may start with any particular process (frequently observation),but thereafter a logical order of process skills will evolve. That is, there are natural relationships between and among the process skills.

Students should be able to operationalize a problem solving strategy by putting together a basic set of processes such as: problem identification, predicting, designing, observing, interpreting, and openendedness. At lower levels, students don't necessarily have to articulate all the "jargon" but through suitable teacher questioning should be able to go through a logical problem solving set of steps when presented with a given event or phenomena. That is, a spiral curriculum up through the grades is necessary to develop student competency in process skill utilization.

There is an inventory of process skills on page 4 of this book. A master list should continuously be referred to so that an ordered perspective is developed relative to the process skills. It should be pointed out that although the processes are numbered from one to seventeen, no rigid order is implied. Scientific investigations do not proceed always in an orderly manner from step one to seventeen. Furthermore, in any given investigation it may not be necessary to include all the steps.

SUGGESTED READINGS

Banff National Park

Parks Canada, Interpretive Planning Team, *Bow Summit Interpretive Management Unit Plan.* Banff, 1977.
– the development plan for Bow Summit, including twelve-page storyline.

Parks Canada. Brochures:
"Bow Summit"
"Banff National Park"
"A Special Place, Banff National Park"
"You are in Bear Country"
"Backcountry User's Guide"

Robinson, S., *The Natural and Human History of Banff.* Parks Canada, Banff, 1980.
– a general overview.

Canadian national parks

Government of Canada, *The National Parks Act.* 1930.
– the legislation.

Lothian, W.F., *History of Canada's National Parks.* Indian and Northern Affairs, Ottawa: 1976. 2 volumes.
– a comprehensive overview.

Parks Canada, *Parks Canada Policy.* Parks Canada, Ottawa, 1979.
– the operating policy of that government branch.

Climate

Janz, B. and Storr, D., *The Climate of the Contiguous Mountain Parks: Banff, Jasper, Yoho, Kootenay.* Environment Canada, Toronto, 1977.
– comprehensive, fairly technical.

Fauna: in the Rocky Mountains

Banfield, A.W.F., *The Mammals of Canada.* The University of Toronto Press, Toronto, 1974.
– a general, comprehensive, book presented by species.

Godfrey, W. Earle, *Birds of Canada.* The National Museum of Canada, Ottawa, 1966.
– a general, comprehensive book, presented by species.

Holroyd, G.L. *et al.*, *The Biophysical Wildlife Inventory of Banff and Jasper National Parks: Interim Report, 1978-79.* Canadian Wildlife Service, Edmonton, 1979.
– a technical, field-analysis report.

Salt, W. Ray and J.R., *The Birds of Alberta.* Hurtig Publishers, Edmonton, 1976.
– identification guide with photographs and illustrations.

Soper, J. Dewey., *The Mammals of Alberta.* Hanley Press, Edmonton, 1965.
– identification guide with photographs and illustrations.

Udvardy, Miklos, D.F., *The Audubon Society Field Guide to the North American Birds: Western Region.* New York: Alfred A. Knopf, 1977.
– a field guide with photographs.

Field trips

MacKenzie *et al.*, "Guidelines for Outdoor Schools." Regina Board of Education, Regina, 1973.

Youngpeter, J.M., *Winter Science Activities.* Holiday House, New York, 1966.

Flora: in the Rocky Mountains

Arno, Stephen, *Interpreting the Timberline: An Aid to Help Park Naturalists to Acquaint Visitors with the Subalpine - Alpine Ecotone of Western North America.* National Park Service, San Francisco, 1967.
- Master's thesis.

Barg, Mriza, *Ecology of Timberline Vegetation in the Rocky Mountains of Alberta.* University of Calgary, Calgary, 1972.
- unpublished Ph.D thesis.

Broad, John, *Ecology of Alpine Vegetation at Bow Summit, Banff National Park.* University of Calgary, Calgary, 1973.
- Master's thesis.

Habeck, J.R. and Hartley, E., *A Glossary of Alpine Terminology.* University of Montana, Missoula, 1968.
- a brief booklet.

Hosie, R.C., *Native Trees of Canada.* Canadian Forestry Service, Queen's Printer, Ottawa, 1969.
- a comprehensive identification guide.

Ogilvie, R.T., *Ecology of Vegetation in Banff National Park.* University of Calgary, Calgary, 1963.
- Master's thesis.

Porsild, A.E., *Rocky Mountain Wild Flowers.* Parks Canada and National Museums of Canada, Ottawa, 1974.
- field guide with illustrations.

Zwinger, A.H. and Willard, B.E., *Land Above the Trees - A Guide to American Alpine Tundra.* Harper and Row, New York, 1972.
- an illustrated overview.

Geology

Adams, George F. and Whykoff, Jerome, *Landforms: A Golden Science Guide.* New York: Golden Press, 1971.
- a basic field guide.

Canadian Society of Petroleum Geologists, *A Guide to the Geology of the Eastern Cordillera between Calgary, Alberta, and Revelstoke, British Columbia.* Calgary, Alberta, 1971.
- a reference to specific features.

Chapman, R.J., *The Mountain Building Story of Banff and Yoho.* Parks Canada, Calgary, 1979.
- comprehensive, with site-specific information.

Nelson, S.J., *The Face of Time: A Geological History of Western Canada,* Alberta Society of Petroleum Geologists, Calgary, 1970.
- well-illustrated overview.

Glaciology

Embleton, C. and King, C.A., *Glacial and Periglacial Geomorphology.* Edward Arnold Ltd., London, England, 1968.
- discusses glacial features, fairly technical.

Rutter, Nathaniel W., *Geomorphology and Multiple Glaciation in the Area of Banff, Alberta.* Ottawa, Geological Survey of Canada, 1972.
- technical.

Sedgewick, J.K. and Henoch, W.E.S., *Peyto Glacier General Information.* Water Resources Branch, Glaciology Division, Ottawa, 1975.
- a technical report.

History

Fraser, Esther, *The Canadian Rockies: Early Travels and Explorations.* Edmonton, Hurtig Publishers, 1969.
- general reading.

Luxton, Eleanor, G., *Banff: Canada's First National Park.* Summerthought Ltd., Banff, 1975.
- general reading.

Recreation

Kunelius, C.E. (Rick), *Ski Trails in the Canadian Rockies.* Summerthought, Banff, 1977.
- general guide.

Patton, Brian, *Parkways of the Canadian Rockies: An Interpretive Guide to the Roads in the Mountain Parks.* Summerthought, Banff, 1975.
- general guide.

Patton, Brian and Robinson, Bart, *The Canadian Rockies Trail Guide.* Shining Mountains, Banff, 1975.
- a general guide.

Science-Process Approach

Carter, J.L. *et al.*, *Life Science: A Problem Solving Approach.* Ginn & Co., Scarborough, Ontario, 1977.

Smallwood, W.L., *Challenge to Science: Life Science,* McGraw-Hill Ryerson, Scarborough, Ontario, 1979.

ISBN 0-919685-11-0

The Bow Summit Edukit is available on slide/tape from your local Field Service Specialist, and on video cassette from the Access Media Resource Centre.

Access Media Resource Centre
Health Sciences Centre
3350 Hospital Drive N.W.
Calgary, Alberta
T2N 4N1
Phone: (403) 283-8241

Arthur Heller
Field Services Specialist
ACCESS Alberta
16930 - 114 Avenue
Edmonton, Alberta
T5M 3S2
Phone: 451-3160
Telex: 037-3948

Glenn Holmes
Field Services Specialist
ACCESS Alberta
Health Sciences Centre
3350 Hospital Drive N.W.
Calgary, Alberta
T2N 4N1
Phone: 283-8241

Allan Vander Velde
Field Services Specialist
ACCESS Alberta
Health Sciences Centre
3350 Hospital Drive N.W.
Calgary, Alberta
T2N 4N1
Phone: 283-8241
Telex: 03-824867

Alec Fleming
Field Services Specialist
ACCESS Alberta
c/o Grande Prairie College
P.O. Bag 1050
Grande Prairie, Alberta
T8V 4C4
Phone: 532-1007

Michael O'Brien
Field Services Specialist
ACCESS Alberta
203, Central Elementary School
48th Avenue & 53rd Street
Red Deer, Alberta
T4N 2E6
Phone: 343-1224

Richard Kushko
Field Services Specialist
ACCESS Alberta
1904 - 13 Avenue North
Chinook Mall
Lethbridge, Alberta
T1H 4W0
Phone: 327-8884

Sam Barsoumian
Field Services Specialist
ACCESS Alberta
St. Paul Regional High School
P.O. Box 2830
St. Paul, Alberta
T0A 3A0
Phone: 645-4333

Unless otherwise noted, teachers and nonprofit organizations may quote from or reproduce this program guide material without permission (for noncommercial purposes).

ACKNOWLEDGEMENTS

Gary Gay, Ph.D.
Patricia McWilliams
Gerry Morgan
Joanne Black

Lynn Hardstaff, Consultant, Parks Canada
Leslie Johnson, Project Manager, Access Alberta

Design & Layout: John Blackie

N.L.C. - B.N.C.
3 3286 06337733 3

For further information contact:
Alberta Educational Communications Corporation
Media Resource Centre
3350 Hospital Drive N.W.
Calgary, Alberta, T2N-4N1
Telephone(403) 283-8241

produced by ACCESS, Alberta for PARKS CANADA

ACCESS Alberta Parks Canada